Teacher Professional Development

Many experts assert that high-quality professional development should enhance student learning, but data for undertaking the requisite analysis are sparse. Almost all teachers participate in some form of professional development over the course of a year, most for the equivalent of a day or less. Teachers who spend more time in professional development activities are more likely to self-report improvements in classroom teaching as the result of these activities than are those who spend less time. Although several reports have asserted that teachers will perform better if they are given opportunities to sharpen their skills and keep abreast of advances in their fields (Henke, Chen, and Geis 2000; National Commission on Teaching and America's Future 1996), there has been no comprehensive assessment of the availability of such learning opportunities and the effects of those opportunities on teachers and students (Mullens et al. 1996; Smylie 1996). This section reviews participation in three types of professional development activities by mathematics and science teachers in 1999/2000:

- ♦ activities focused on indepth study of their content areas,
- ♦ activities focused on methods of teaching, and
- ♦ activities focused on the use of computers for teaching.

The amount of time teachers spent in these activities and whether they found them useful are also reviewed.

Nationally representative data on teacher quality, professional development, and working conditions have been collected by the National Center for Education Statistics' (NCES) 1999–2000 Schools and Staffing Survey. They were not available in time for the preparation of this chapter. Following release of the dataset by NCES, analyses of these topics will be available at the following National Science Foundation website: <http://www.nsf.gov/sbe/srs/seind02/update.htm>.

Observation of Other Teachers Teaching

Some research suggests that the experience of teachers observing other teachers can contribute to the sharing of good practices. TIMSS-R asked the mathematics and science teachers of U.S. 8th-grade students during the 1998/99 academic year about the number of class periods they observed other teachers during the past year and the number of periods other teachers observed them during the past year (NCES 2000f).[11] In general, the mathematics teachers of U.S. 8th-grade students rarely participated in observational activities. On average, U.S. 8th-grade students were taught by mathematics teachers who spent one class period during the 1998/99 academic year observing other teachers and who were observed by other teachers during two class periods. There were no differences in the average number of class periods that mathematics teachers observed other teachers or were observed by other teachers based on years of teaching experience.

The science teachers of U.S. 8th-grade students also rarely participated in observational activities. On average, U.S. 8th graders were taught by science teachers who observed other teachers for one class period during the 1998/99 academic year and who were observed by other teachers for one class period. However, the situation was different for U.S. 8th-grade students whose science teachers had the fewest years of experience (0–5 years): their teachers spent approximately three periods observing other teachers, a greater number of periods than science teachers with more years of experience (NCES 2000f).

Teacher Working Conditions

Salaries for math and science teachers remain well below those of bachelor's and master's degree scientists and engineers in industry. Given that teacher retirements are on the rise, increased salaries provide a means of retaining good teachers and attracting the number of quality teachers needed to replace retirees. The difference between the annual median salaries of all bachelor's degree recipients and teachers has declined over the past 20 years, mainly due to increases in the relative size of the older teaching workforce and in salaries of older teachers. This section reviews how average teacher salaries have changed over the past quarter century, how the earnings of math and science teachers vary in high- and low-poverty schools, and, finally, how the salaries and teaching time of U.S. teachers compare with those of their counterparts in other countries.

Salary and teaching time are only two components of teacher working conditions. The amount of professional development time supported by a school or district, student behavior, participation in school decisionmaking, class size, quality of facilities, and adequacy of resources are examples of conditions that could also influence a teacher's desire to teach or not teach at a particular school. Many of these conditions, however, are either difficult to measure or do not have a parallel in S&E occupations outside teaching.

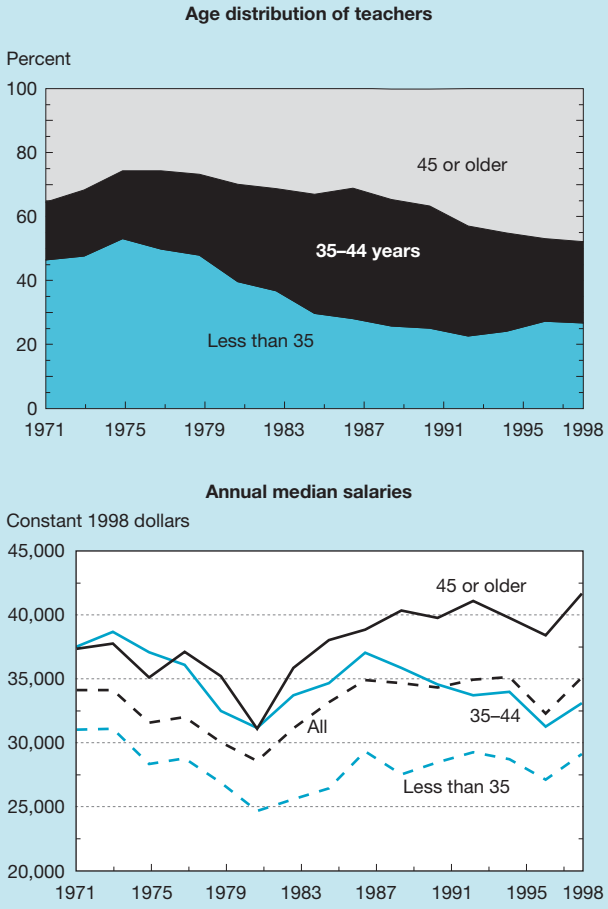
Trends in Teacher Salaries

As a wave of younger teachers hired in the mid-1970s has aged, a demographic shift in the age of teachers has occurred (NCES 1999a). For example, in 1975, 53 percent of all full-time teachers were younger than age 35; in 1993, the percentage of younger teachers fell to about 23 percent. By 1998, the percentage of younger teachers had risen only slightly, reaching 27 percent. Meanwhile, the percentage of full-time teachers age 45 years or older increased from about 26 percent in 1975 to 48 percent in 1998. (See figure 1-15.) Average teacher salaries have been affected by these demographic shifts, particularly over the past 20 years.

The annual median salaries (in constant 1998 dollars) of full-time teachers decreased between 1971 and 1981 by about

[11] Questions regarding the professional development of teachers, including whether or not they had observed other teachers teaching in the previous year, were only asked of U.S. mathematics and science teachers in TIMSS-R.

Figure 1-15.
Age distribution and annual median salaries by age of full-time elementary and secondary school teachers: 1971–98



NOTE: Median salaries refer to previous calendar year, for example, salaries reported in 1971 refer to salaries earned in 1970. Consumer Price Index (CPI) used to calculate constant dollars. Includes full-time public and private school teachers who taught grades 1–12.

SOURCE: National Center for Education Statistics, *The Condition of Education 1999*, NCES 1999-022 (Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement: 1999a).

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$500 to $700 annually in each age group. Between 1981 and 1989, the salaries of teachers rose. The annual median salary of full-time teachers grew slowly during the 1990s, reaching $35,099 in 1998 (NCES 1999a). For the oldest group of teachers, salaries rose by about $1,100 per year on average, while for the middle-aged and youngest groups, salaries increased by smaller amounts. Since 1989, the salaries of the oldest and youngest groups of teachers have remained about the same, while the salaries of the middle-aged group (between ages 35 and 44) have declined by about $400 per year on average. (See figure 1-15.)

The difference between the annual median salaries of bachelor's degree recipients and all full-time teachers declined from about $5,000 in 1981 to $2,300 in 1998. This decline in the salary gap has been due mainly to increases in the relative size of the older teaching workforce and in the salaries of teachers age 45 or older (NCES 1999a).

Variation in the Salaries of Math and Science Teachers

Many believe that competitive salaries and benefits are key to attracting and retaining high-quality teachers (Murnane et al. 1991). Research has shown that levels of compensation and criteria for awarding salary increases affect who goes into teaching, who stays, and how teachers move from district to district and from school to school (Odden and Kelley 1997). When asked whether various factors were important to them in determining the type of work they planned to do in the future, 1992/93 bachelor's degree recipients responded affirmatively to "income potential over career" and "intellectually challenging work" (45 percent in each case) more often than to any of the other factors mentioned (Henke et al. 1997). This section examines variability in the compensation levels of mathematics and science teachers in 1999/2000 across high- and low-poverty districts by school location.

Nationally representative data on teacher quality, professional development, and working conditions have been collected by the National Center for Education Statistics' (NCES) 1999–2000 Schools and Staffing Survey. They were not available in time for the preparation of this chapter. Following release of the dataset by NCES, analyses of these topics will be available at the following National Science Foundation website: <http://www.nsf.gov/sbe/srs/seind02/update.htm>.

International Comparisons of Teacher Salaries

Internationally, teacher pay scales in the United States tend to be lower than those in a number of other countries, including Germany, Japan, South Korea, and the Netherlands, and teaching hours tend to be longer. The gaps are particularly wide at the upper secondary (high school) level because a number of countries, unlike the United States, require higher educational qualifications and pay teachers significantly more at this level than at the primary (elementary) level. For example, salaries for upper secondary teachers with 15 years of experience and the minimum level of education and training required to be certified exceeded $40,000 in 1998 in Denmark, Germany, Japan, and the Netherlands and exceeded $60,000 in Switzerland (Organisation for Economic Co-operation and Development (OECD) 2000). The comparable salary for the United States was $35,000. This section reviews cross-country variation in teacher salary, adjusting first for differences in country wealth or ability to spend on education, and second for differences in the amount of time that teachers are required to spend in instructional activities to earn their salaries.

Association Between Teacher Salaries and Per Capita Gross Domestic Product

Teacher salaries relative to per capita gross domestic product (GDP) are an indication of the extent to which a country invests in teaching resources relative to the financial ability to fund educational expenditures. A high salary relative to per capita GDP suggests that a country is making more of an effort to invest its financial resources in teachers. Relative to per capita GDP, teacher salaries are relatively low in the Czech Republic, Hungary, and Norway and relatively high in South Korea, Spain, and Switzerland.

Wealthier countries do not necessarily spend a greater share of their wealth on educational resources, however. (See figure 1-16.) Although the Czech Republic and Hungary have both relatively low GDP per capita and low teacher salaries, other countries with GDP per capita below the OECD average, including South Korea and Spain, have comparatively high teacher salaries. Norway and the United States, two countries with relatively high GDP per capita, spend a below-average share of their wealth on teacher salaries, and Switzerland spends an above-average share of its relatively high per capita GDP on teacher salaries.

Salaries Adjusted for Statutory Teaching Time

Another measure of the investment in teaching is the statutory teacher salary relative to the number of hours per year that a full-time classroom teacher is required to teach students. This measure reflects the fact that teaching time is organized differently across countries, influenced by both the number of instructional hours planned for students each year and the proportion of the working day that a full-time teacher is expected to be engaged in direct instruction. Although this measure does not adjust salaries for the amount of time that teachers spend in all teaching-related activities, it can nonetheless provide a rough estimate of the cost of an hour of instruction across countries.

The average statutory salary per teaching hour after 15 years of experience is $35 in primary education, $43 in lower secondary education, and $52 in upper secondary (general) education across OECD countries (OECD 2000). For primary education, the Czech Republic, Hungary, and Mexico have relatively low salary costs per hour of instruction ($13, $15, and $16, respectively); by contrast, costs are relatively high in Denmark ($48), Germany ($49), South Korea ($62), and Switzerland ($48). Salary costs per primary teaching hour in the United States are in the middle of this range at $35. In South Korea, high costs per teaching hour at the primary level are balanced by a relatively high student/teacher ratio (31.2) and a low proportion of current expenditure on nonteaching staff, resulting in below-average expenditure per student (OECD 2000). In contrast, Denmark's high costs per teaching hour at the primary level combine with a relatively low student/teacher ratio (11.2) and an above-average expenditure on nonteaching staff to create one of the highest expenditure-per-student figures in the OECD. There is more variability in salary cost per hour of teaching in upper secondary schools, ranging (among OECD countries) from $16 or below in the Czech Republic and Hungary to $90 or above in Denmark and South Korea. Comparable costs for the United States were $38.

IT in Schools

Although myriad approaches have been proposed for improving K–12 education in the United States, one common element of many such plans is more extensive and more effective utilization of computer, networking, and other information technologies (IT) to support a broad program of systemic and curricular reform (President's Committee of Advisors on Science and Technology 1997). IT has fundamentally transformed America's offices, factories, and retail establishments. Although the transformation in schools has been quite modest by comparison, technology and computers are rapidly appearing in schools and classrooms, and their integration into the curriculum is redefining the perception of a quality school (NCES 2000d).

Computers and Internet access are used in a variety of ways in schools, and each use may have an independent effect on student learning. Relatively little research on the effect of technology on learning looks at the uses and effects of Internet access; most research examines the instructional power of the computer to teach discrete skills (NCES 2000d). Numerous studies conducted in the elementary and secondary grades have concluded that student learning is enhanced by computers when the computer is used to teach discrete skills in the style referred to as "drill and practice." The benefits appeared to be strongest for students of lower SES, low achievers, and those with certain learning problems (President's Committee of Advisors on Science and Technology 1997).

Research on the application of computers for developing higher order thinking skills, problem-solving, group work, and hands-on learning activities, however, is less extensive and less conclusive (NCES 2000d). Two studies show positive effects (Wenglinsky 1998; Glennan and Melmed 1996), but a third study concludes that it is not known whether computers can be used for this type of teaching in a cost-effective manner with any "degree of certainty that would be desirable from a public policy viewpoint" (President's Committee of Advisors on Science and Technology 1997). Although it is possible that these studies are less conclusive because teachers are less adept at teaching using these new tools, it is clear that IT is becoming increasingly important in the classroom and that there is widespread interest in how these tools are being applied.

This section first examines student and teacher access to IT at school. Variability in access across high- and low-poverty schools is emphasized. Next, teacher use of IT in the classroom and at home, teacher preparation and training in IT, and barriers to IT use are examined. Because computers are not the only technology used in schools, the section concludes with a discussion of calculator usage in mathematics classes and how this varies cross nationally.